MINNESOTA

Grid Soil Testing and Variable-Rate Fertilization for Profitable Sugarbeet Production

By Larry J. Smith and Doug Rains

Grid sampling should identify variability in nutrient status. Coupled with variable-rate fertilization, it should provide the crop with optimum fertility during the season, yet not waste fertilizer on areas of excess or adequate nutrients. Of particular importance to sugarbeet quality is excess available nitrogen (N), especially below 2 ft. deep in the soil profile.

A study conducted jointly by university and industry shows why the Red River Valley of the North has become a hot bed of precision agriculture activity.

Red River Valley Study

There were several objectives of this study. 1) Determine the variability in nitrate-nitrogen (NO_3-N) levels at depths of 0 to 4 ft. across the field used in commercial sugarbeet production. 2) Use grid soil sampling to ascertain if variable rate application of fertilizer corresponding to grid soil sampling versus random soil sampling in broadcast fertilization will increase yield, quality and profitability. 3) Follow the nutrient status of the field in years following sugarbeets to determine if, how and why variability in nutrient status changes.

This study was conducted at the Northwest Experiment Station at the University of Minnesota in a 62 acre field in 1994 and a 70 acre field in 1995. The fields were in a 4-year sugarbeet rotation (sugarbeet, wheat, corn, barley) and were conventionally and grid soil sampled in mid-October to determine nutrient status. Headlands were not included in either sampling or used in the trial. Nitrate-N status was determined at the 0 to 6 inch, 6 to 24 inch and 24 to 48 inch depths. Phosphorus (P) and potassium (K) were determined on the 0 to 6 inch sample. Conventional sampling consisted of 30 to 40 probes in a random pattern throughout the field. Grid size was 370 x 359 ft. (3 acres) in 1994 and 566 x 212 feet. (2.8 acres) in 1995. Each block was sampled six times.

TABLE 1. Summary of available soil NO_3-N levels and fertilizer recommendations from 1994 and 1995 locations.

Factor		N, lb/A[1] 1994	1995
Available soil NO_3-N from conventional sampling		95	83
Average available soil NO_3-N from grid sampling		81	76
Range in available soil NO_3-N from grid sampling		21-180	39-102
Conventional N recommendation		25	37
Variable rate N recommendation:	Average	63	78
	Range	0-100	26-100
% of field underfertilized using conventional sampling		65	79

[1] NO_3-N from 0 to 2 ft + 80% of the NO_3-N in the 2 to 4 ft increment that exceeds 30 lb/A.

TABLE 2. Sugarbeet yield, quality and gross returns.

Factor	1994 Location		1995 Location		2-year average	
	Conv.	Variable	Conv.	Variable	Conv.	Variable
Yield, tons/A	24.3	25.5	22.9	23.9	23.6	24.7
Recoverable sucrose, lb/ton	287	296	286	293	287	295
Recoverable sucrose, lb/A	6,982	7,555	6,542	6,976	6,762	7,266
Gross return, $/A	898	994	848	921	873	958

The fields were divided into four strips with two receiving a blanket broadcast application of N based on the conventional soil test and two being variable rate-fertilized based on the grid test results. The trial was designed to look only at N fertilization. A broadcast application of 46 lb/A of P_2O_5 was made to the entire field to insure adequate P availability.

The study was harvested using conventional field equipment. Each of over 100 truck loads was weighed and two samples removed for sugar analysis.

The Results

Grid soil sampling gave a far more accurate estimation of available soil N in the 0 to 4 ft. profile than did conventional sampling (**Table 1**). Substantial areas were under-fertilized each year using conventional sampling and the resulting single fertilizer rate for the entire field.

Variable rate fertilization out performed the conventional methods of soil testing and fertilization in both years of the study (**Table 2**). Both yield and sugar content were higher for the variable rate treatment leading to an average increase in gross return of $85/per acre. Additional costs incurred by the variable rate approach from sampling, testing, application, and extra fertilizer totaled $25/per acre, leaving an average net return to variable rate N of $60/per acre (**Table 3**). These are actual costs being charged for this region and will vary with field, grid size and company.

Summary

Grid sampling and variable rate fertilization are tools that will hopefully improve the sugarbeet grower's bottom line. Variable rate fertilization of fields with excessively high NO_3-N in the 2 to 4 ft. soil profile over the majority of the field probably will not improve sugar content or reduce loss to molasses. Grid sampling will give a better picture of where excess soil NO_3-N levels exist and, if used correctly, may help reduce the levels before sugarbeets are again planted in a particular field. BC

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TABLE 3. Profit analysis for two years of variable rate N for sugarbeets.

Factor	Conventional	Variable	Difference (Var.-Conv.)
Gross return, $/A	$873.00	$958.00	+$85.00
Soil sampling and testing, $/A	0.70	12.80	-12.00
Fertilizer application, $/A	3.50	8.50	-5.00
Fertilizer N costs, $/A	6.20	14.10	-8.00
Net return to variable rate N, $/A	863.00	923.00	+60.00